Dietary Assessment & Evaluation of Nutritional using Image Segmentation for Mobiles: Survey

Dr.N.Sasikala[1], G.Shruthi[2], E.Swapna[3]

Department of Electronics & Communication Engineering, Kamala Institute of Technology & Science, Singapur, Telangana

Abstract— *There is a great demand for easily accessible user friendly dietary self assessment and self management applications. This is because of growing concern about chronic diseases and other health problems related to cancer and obesity. So accurate diet measurement is very important. Measurement of accurate dietary and development of fully automatic estimation of nutritional intake is considered to be an open research problem. In this paper a survey on mobile telephone food record has been done. This mobile telephone food record provides an accurate account of daily food and nutrient intake of an individual. The identification and quality estimation is based on obtaining images before and after consumption of meal. Image analysis is done which includes the segmentation of food items, identification of food items by its features, automatic estimation of food portion.*

Keywords— dietary assessment, diet record method, image analysis, nutrient computation, volume estimation.

I. INTRODUCTION

Chronic diseases, health problems related to diet like obesity and cancer has wide spread all over the world. Obesity is related to number of chronic diseases [13] such as type II diabetes, cholesterol, colon, breast cancer and heart disorders. The lack of balance in the eating habits is the reason for obesity. Obesity treatment is based on patient dietary intake. Dietary intake refers to the process of determining the food consumed by an individual during the course of a day. This provides valuable insights for prevention of many chronic diseases. Dietary intake measurement [19][17] is considered to be an open research problem. There should be accurate methods and tools to access the food and nutrient intake. Monitoring of nutritional status of a person is important for further clinical research. The dietary information provides the reasons for the occurrence of the disease. The dietary information also helps to use methods that prevent from the occurrence of disease.

The accurate assessment of diet is a crucial task. This task can be handled effectively if there is an availability of smart mobile phone [17] which has high resolution, imaging capability, a very fast processor, network connectivity and high memory capacity. Instead of record keepers, mobile phones [14][17] are used which provides a unique mechanism for collecting dietary information[22][17]. Dietary assessment using mobile phone improves accuracy and efficiency over personal digital assistant (PDA) with or without camera or a disposable camera.

Images are acquired before and after the consumption of food. Mobile has built in camera, by using that images are acquired, image analysis is done (like area and volume estimation before and after consumption of meal), then volume estimation [17] is done. Once the volume is estimated it is compared in the nutrient database.

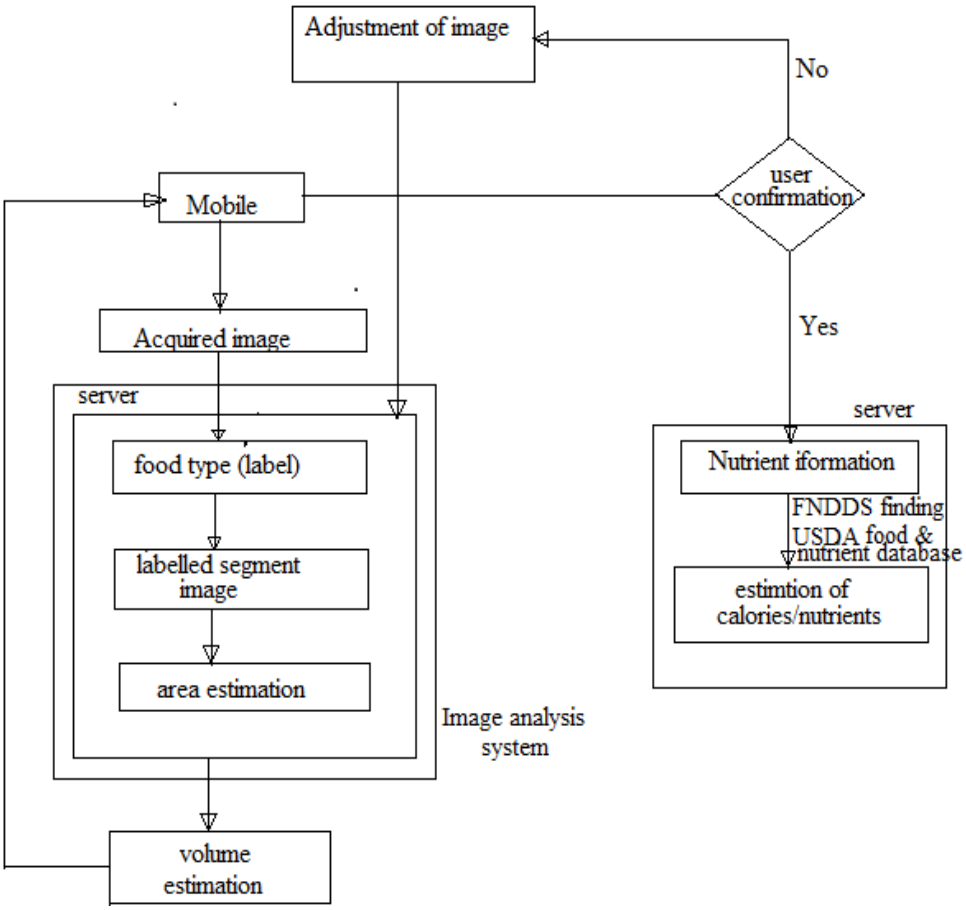

FIGURE 1: System Architecture

II. IMAGE ANALYSIS SYSTEM

Previously many works have been carried out for the automatic recognition of some types of food. A color image is taken and then it was converted into high contrast gray scale image. Intra class variance is minimized by statistical approach like global thresholding [17] of the segmented image. Small objects are removed or some areas filled by implementing morphological operations [15] like dilation and erosion in the segmented regions. For this process 5 to 6 images of the scene are utilized.

Later methods are developed which estimates the food consumption using a single image acquired from mobile device. In this method each of the food items is segmented, and is identified, then volume is estimated. Images are taken before and after meal which are used for the estimation of food intake. From this information the energy and nutrients [16][17] consumed can be determined.

III. IMAGE SEGMENTATION

Segmentation of the food image is done using connected component analysis active contour and normalized cuts. The amount of food in the image is measured by using a simple method. This method involves the use of a calibrated fiducial like checkerboard [17] that is placed in the field of view of the camera. With the help of this marker geometric and color correction to the images are made so as to estimate the amount of food present.

3.1 Connected component labeling

There are two steps to segment food using connected components. In the first step the colour image is converted to grey scale and then thresholding [17][12] is done so that it converts into a binary image. This method is done in order to separate the food plate from the background (like table cloth). Later segmentation of food from the plate is done by eight point connected

neighbors for the low intensity value (i.e., 0) in the thresholded image (binary image). Since fixed threshold was used, pixels corresponding to the food items can be identified and the rest of the pixels can be labeled as plate.

Next the RGB image is converted in to YCbCr colour space. The mean value of histogram [17] corresponding to the plate is found by sing Cb and Cr chrominance components. Pixel locations that are not segmented during the first step are compared with the mean value of the colour space histogram of the plate in order to identify the food items. These pixels are given different label from that of the plate. Eight point connected labels for the labeled pixels are searched to segment the food item.

3.2 Active contours

Techniques of curve evolution is use to detect objects by active contours method. The curve is deformed to the boundary of the object. This method is suitable for images with strong object boundaries [4][17], but are sensitive to the initialization of the active contour. Therefore region base models [18][17] are preferred which identify each region of interest by using region descriptor to guide the motion of active contour. These methods relay on the intensity homogeneity in each of the regions to be segmented and are less sensitive to the initialization of active contour. By this method partition of the image into foreground and background regions can be done. If multiple food items are connected then this model fails. Active model contour works only when the food items are separated from each other.

3.3 Normalized cuts

Normalized cut is a graph partition method [6] which treats an image pixel as a node of graph and segmentation [3][17] as a graph partitioning problem. Image is modeled as a weighted, undirected graph. Each pixel is a node in the graph, and edge is formed between every pair of pixels. The measure of the similarity between the pixels is the weight of an edge[10][17].

IV. FOOD FEATURES

Color and texture are the two features that are extracted and measured for each segmented food region. Food images are taken by placing fiducial marker consisting of color checkerboard that is placed in the field view of the camera. This helps in taking the image correctly i.e. helps to correct for color imbalance in the mobile devices camera [5][17]. Color features are obtained by taking average value of pixel intensity along two color components, luminance component and two chrominance components. For texture features gabor filters [17] are used to measure local texture properties in frequency domain. Gabor filters are used for describing properties related to the local power spectrum of a signal, and this is used for texture analysis. Gabor filter is highly suitable for obtaining texture features. Each image is subjected to gabor filtering operation in a window around each pixel, and then mean is estimated along with standard derivation of energy of the filtered image

V. CLASSIFICATION

Classification is the process of identifying food items using statistical pattern recognition techniques based on the segmentation of food items and feature extraction. Support Vector Machines (SVM) is used for the classification [21][17] of food items. Classification involves training and testing data. Each element in training set contains one class label and several features. The features of training images are extracted and training model is generated using the SVM. The food that is labeled along with the segmented image is sent to the automatic portion estimation module where camera parameter estimation and model reconstruction are used to determine the volume of food.

5.1 Volume estimation

Estimation of size of food portion from a single image is the challenging problem of image based dietary assessment. Volume estimation utilizes camera parameter estimation and mode reconstruction to determine the volume of food items. From this estimated volume the nutritional content can be determined. Volume estimation consists of camera calibration and 3D volume reconstruction [4][23] for this process two images are used as inputs. First image is the food image taken by the user and the second image is the segmented image. Later estimation of camera parameters intrinsic and extrinsic is done. Intrinsic parameters are like distortion the principal point and focal length, while the extrinsic parameters are cameras

translation [20][17] and orientation. Fiducial marker is used as a reference which poses the food. The fiducial marker is detected in the image and the pose is estimated.

The system which estimates the volume partitions the space of objects into geometric classes each with their own set of parameters. Features are extracted from the segmented region image and unprojected into 3D space. Based on the parameters of geometric class, 3D volume is reconstructed from the unprojected points. Once the volume estimation of food is made, nutrient intake consume is estimated based on USDA Food and Nutrient Database for Dietary Studies (FNDDS) [16].

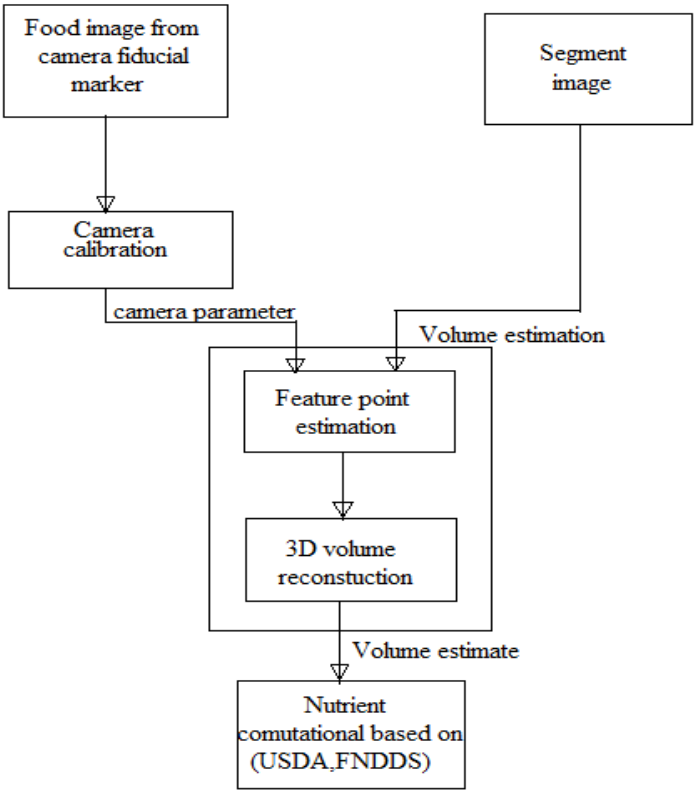

FIGURE 2: Volume estimation

VI. CONCLUSION

This is a survey paper on the Dietary assessment system using mobile devices. A measurement method was used which estimates the amount of nutrients in food image by extracting the volume of food using fiducial marker. This aids the dietitians for the treatment of obese or over weighted people or normal people so that they can have a check on eating habits. Identification of food image, image analysis, volume estimation is done which helps in building the system architecture. These techniques/methods will be useful in replacing the traditional food record methods that are currently in use. This survey is done on simple type of food. Further work/research can be carried out for multiple food items which are placed together (overlapping) on a plate. Segmentation of such food items and volume estimation is a challenging research problem.

REFERENCES

[1] Fengeqing Zhu, Marc Bosch, Carol J. Boushey and Edward J. Delp. Multilevel Segmentation for Food Classificaton in Dietry Assessment. PMC 2011 November 27.

[2] Anastasia Sofou and Petros Maragos. Generalized Flooding and Multicue PDE-Based Image Segmentation. IEEE Transactions on Image Processing, Vol.17, No.3, March 2008.

[3] Fengeqing Zhu, Marc Bosch, TusaRebecca Schap, Nitin Khann, David S. Ebert, Carol J. Boushey and Edward J. Delp. Segmentation Assisted Food Classification for Dietry Assessment. NIH Public Access PMC 2011 November 27.

[4] Hisn-Chen Chen, Wenyan Jia, Yaofeng Yue, Zhaoxin Li, Yung-Nein Sun, John D.Fernstrom and Mingui Sun. Model-based measurement of food portion size for image-based dietry assessment using 3D/2D registration. NIH Public Access PMC 2014 October 01.

[5] Mengyao Zhao, Chi-Wing Fu, Jianfei Cai and Tat-Jen Cham. Real-Time and Temporal-Coherent Foreground Extraction With Commodity RGBD Camera. IEEE Journal of selected topics in signal processing, Vol.9, No.3, April 2015.

[6] Francisco J. Estrada and Allan D. Jepson. Benchmarking Image Segmentation Algorithms. Springer, 28 May 2009.

[7] Xiaofang Wang, Yuxing Tang, Simon Masnou and Liming Chen. A Global/Local Affinity Graph for Image Segmentation. IEEE Transactions on Image Processing, Vol.24, No.4, April 2015.

[8] Carreira, J.; Sminchisescu, C. Constrained parametric min-cuts for automatic object segmentation. Proceedings of the IEEE Conference on Computer Vision and Pattern Recognition; 2010 June, p.3241-3248.

[9] Zhu F, Bosch M, Woo I, Kim S, Boushey CJ, Ebert DS, Delp EJ. The Use of Mobile Devices in Aiding Dietary Assessment and Evaluation. IEEE Journal of Selected Topics in signal Processing 2010 August; Vol. 4(no.4):756-766. [PubMed: 20862266].

[10] Shi J, Malik J. Normalized cuts and image segmentation. IEEE Transactions on Pattern Analysis and Machine Intelligence. 2000; vol. 22(no.8):888-905.

[11] Zhu, F.; Bosch, M.; Delp, E. An image analysis system for dietary assessment and evaluation; 2009 17th IEEE International Conference on Image Processing (ICIP); Hong Kong, China. 2010 September.

[12] Jain, AK.; Farrokhnia, F. Unsupervised texture segmentation using gabor filters. Proceedings of the IEEE International Conference on Systems; Man and cybernetics; Los Angeles, CA. 1990 November.

[13] Key TJ, Schatzkin A, Willett WC, Allen NE, Spencer EA, Travis RC. Diet, nutrition and the prevention of cancer. Public Health Nutrition. 2004; 7:187-200. [PubMed: 14972060].

[14] Kong F, Tan J. Automatic dietary assessment with mobile camera phones. Journal Pervasive and Mobile Computing.

[15] Gonzalez, RC.; Woods, RE. Digital Image Processing. 3.Prentice Hall; 2007.

[16] Bodner-Montville J, Ahuja JKC, Ingwersen LA, Haggerty ES, Enns CW, Perloff BP. USDA food and nutrient database for dietary studies: released on the web. Journal of Food Composition and Analysis. 2006; 19:S100-S107.

[17] Fengqing Zhu, Marc Bosch, Insoo Woo, Sung Ye Kim, Carol J. Boushey, David S. Ebert and Edward J. Delp. The Use of Mobile Devices in Aiding Dietary Assessment and Evaluation. IEEE Journal of Selected Topics in Signal Processing, Vol. 4, No. 4, August 2010.