International Journal on Future Revolution in Computer Science & Communication Engineering
Volume: 4 Issue: 4
ISSN: 2454-4248
98 – 102

Calorie Estimation from Fast Food Images Using Support Vector Machine

Hemraj Raikwar
Student
SoS in engineering & Technology
Guru Ghasidas Vishwavidyalaya
Bilaspur(CG)
hemrajraikwar@gmail.com

Himanshu Jain
Student
SoS in engineering & Technology
Guru Ghasidas Vishwavidyalaya
Bilaspur(CG)
himanshujainnewai@gmail.com

Amit Baghel
Assistant professor
SoS in engineering & Technology
Guru Ghasidas Vishwavidyalaya
Bilaspur(CG)
Amit_kumar_baghel@rediffmail.com

Abstract: Calorie estimation is one of the interesting area of research nowadays. The proposed model focuses on estimation of number of calories in the food item by just taking its image as input. Some image processing operations are performed on the image of food item followed by machine learning technique known as support vector machine(SVM). We took data from different resources [20] [21] [22], compile them to create our own dataset. Augmented dataset is used to train the SVM model and results show an accuracy of 90.66%. The experiments we performed conforms the feasibility of the proposed model.

Keywords**:** *Calorie, image processing, machine learning, support vector machine, dataset.*

*****

I. INTRODUCTION

As the like for trend and variety of fast food items is increasing, people are also becoming more aware and conscious about calorie intake as the higher number of calorie intake creates a lot of problems like obesity, hypertension, high cholesterol, diabetes, heart attack etc **[1]**. that invokes the need of medical consultancy. People suffering from such problems require an easy way to control their calorie whereas others take it as a step towards prevention.

Many systems built for performing the same task requires the manual input of food items, their ingredients, amount and some other specific details which becomes a tiresome process and the users of any system wants it to be user friendly and easy to access and use**[23]**. Using image as an input and providing to the system to give the result is supposed to be a lot easier. Hence, in our proposed model we allow users to take the picture of food item and input it to the system and the rest of work will be accomplished by the machine rather than user.

The proposed model applies some techniques of image processing followed by feature extraction. Then it performs learning on the dataset provided to it, and then it predicts the input image based on its feature vector obtained by feature extraction. Hence, the ultimate objective of the proposed model is to predict the number of calories of an image representing food-item and it consists of several intermediate activities which are: extracting the feature vector of image, identify the food item in the image, predict the calorie content of the food item in the image.

We took images from some standard food datasets which are available online and designed our own dataset. Histogram of Oriented Gradients(HOG)**[17]**is the feature extraction algorithm used and for classification, the algorithm used is Support Vector Machine(SVM)**[18]**.In short, the proposed model consists of following 5 steps: In first step we took images from different resources and designed our own dataset to provide better input to the proposed model. In second step, we performed some pre-processing on the dataset like background removal, cropping, resizing, augmentation etc. In third step, we applied feature extraction technique known as Histogram of Oriented Gradients which takes into account various information hidden in a digital image. Fourth step consists of feeding the learning algorithm with the features extracted in the previous step that learns and classifies food items according to the category they should belong to. The algorithm runs on an input consisting of 3,200 images. And in the final step, we tested the system with 648 images and conclusion is drawn on the basis of results generated by the model.

II. RELATED WORK

Different calorie measurement models have been developed for research and patient health diagnosis and prescription. Most of the systems either developed or proposed lack either in user friendliness and accessibility or performance and accuracy or some other parameters. Several such models are enumerated below:

A model named Diawear System **[2]** was developed to assist and monitor diabetic patients based on the calorie intake which is estimated from the image of food from user's plate. It was an activity recognition and content aware wearable food model. Limitations of the model include use of wearable device and accuracy for only specific meal. A mobile application named **DDRS [3]** (Diet Data Recorder System) was designed that comprises of a smartphone and a laser package and an application for collecting data and controlling laser. The algorithm**[3] [4]** used also takes into account the volume of food which was the major source of error. The model also requires questionnaires on food intake and hence it is less user friendly. **[5][6]**

Another similar model was proposed that predicts whether the given food item is rotten or not. It implements **SARAN[7]** (Self-Adaptive Resource Allocation Network) and uses standard calorie tables and BMI **[8]** of the person and predicts whether the food item is suitable or not for a person.Tatsuya et al **[9]** designed a model that tried to predict the calorie content of food item by using feature descriptors of food image like colour correlogram, SURF features, colour histogram.Mei et al **[10]** built discriminative machine learning model that classifies food images by using bag of SIFT and colour histogram.

A web-based meal logging model was proposed by Kitamura et. Al.**[11]** which analyses food images provided by users and work as a dietary management system. The model was allowed to be used by users in such a way that they can see the nutritional composition identified by the model and they can correct the results if there is any discrepancy in the prediction of composition of food. The model was found to have a good accuracy level due to personalization**.** Pouladzadeh et. Al.**[12]** had proposed a model with some image classification technique and recognition algorithms that takes into account various properties of food items like colour, shape, size and texture.

The accuracy achieved by the combination of different such features was found to be 92.6%.

Another similar model introduced for calorie estimation used a calibration card**[13]** which is a fixed object as a reference. The card placed with the food before taking the image plays a role of reference with the help of which, the dimensions and weight of item in the food can be predicted. The model suffered from the limitation that it cannot work without the reference card. A system named PDA (personal digital assistive) was developed for the purpose of calorie measurement **[14]**. The model was used by patients where patients record their food intake on a mobile phone on daily basis. But the model takes significant time to record the information provided by the users. Further, the results revealed that the estimation was having significant errors in the predicted food items and their corresponding calorie content **[15]**.

A common problem of most of the models designed in this area is the identification of meal. A model named IMG2 **[16]**was developed that overcome this problem and it used a combination of image recognition and comparatively analysing the image to identify the meals and fruits from photos with average quality of resolution. The system utilizes depth of pixels and size of food relative to a fixed plate. It recognized the calorie content of two eggs, three strips of bacon and two pancakes but most of the work done was not worthy of the task to be achieved.

Most of the models developed are found to have some demerits. Some of them lack precision, others require a lot of user intervention. Such models are expected to be reasonably complex because they take into account the texture features which do not improve efficiency to a good extent.

III. PROPOSED MODEL

A model with low cost and low complexity providing results with greater level of accuracy and feasibility is supposed to be good. In our proposed model, we designed the dataset, apply this dataset to some image processing techniques, then processed dataset is applied to the feature extraction process(**HOG**). The features extracted for all the images are then applied to the classifier(**SVM**) which classifies the images in different classes as specified in the learning algorithm. Every class is associated with a calorie value. Now the system can be used to predict a food item that belongs to one of the categories used in the dataset.

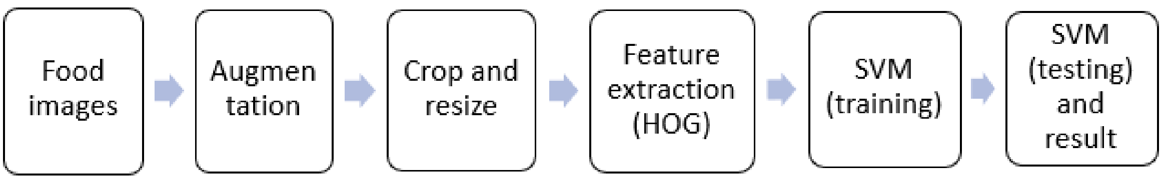

Figure 1: project workflow

1. **Pre-processing:** The analysis shows that the images give better results on a white background and the images give better results if they fed to the system after presenting them to the system as they are expected to be and hence pre-processing of images is required. It includes background subtraction to remove noise and unnecessary information. Augmentation is performed to provide a 360-degree view of the object to be identified. Resizing of image is done to achieve sufficient number of features as well as to reduce the complexity of further computation. Labelling of images is done for sorting and identification purpose.
2. **HOG (Histogram of Oriented Gradients) feature extraction:**Histogram of Oriented Gradients a feature extraction algorithm **[17]** that calculates and provides feature descriptor of an image on the basis of local observable features of the image. The algorithm takes the image as a collection of cells and blocks, scans the image and identifies intensity variations and gradients. Feature descriptor so obtained is sufficient to observe

shape of food item and internal patterns of the food item.

3. **SVM (Support Vector Machine):**Support Vector Machine is a machine learning algorithm**[18]** that has the ability to distinguish among different types of patterns fed to it. SVM tries to compute optimal hyperplanes and maps the points belonging to different categories or classes into distinct spatial regions separated by optimal hyperplanes. SVM provides two different versions for multiclass classification but we both of them provides same accuracy level and hence we use one against one method due to its advantage of less complexity.SVM can perform the task of classification as well as regression**[19]** and it is supervised machine learning algorithm but it is mainly used for classification type of problems. The algorithm creates a space with as many dimensions as there are features in the objects to be classified. In our case, the objects to be classified are images of different kind of fast food items. Then the algorithm maps the objects in the space so generated on the basis of values in the features. After mapping all the features in the space, these features are treated as points and these points are classified by calculating, identifying and drawing hyper-planes. Hyperplanes are chosen in such a way that differentiates the various classes very well. SVM algorithm chooses optimal hyperplanes to reduce error and increase accuracy. Optimal hyperplanes are those hyperplanes which have got higher margin than others but classifies the objects accurately. SVM algorithm also takes into account outliers and ignores them if their exclusion gives better classification. Tuning of the parameters of the algorithm improves its performance significantly. SVM provides three different varieties in its **kernel**. It can be linear, rbf or poly. Rbf refers to radial basis function kernel. Poly and rbf are supposed to be more helpful in non-linear kind of classification. Data with high dimensionality is supposed to be of linearly separable as it happens to be. There is a trade-off between classifying the training points accurately and smooth decision boundary which can be controlled by the **penalty parameter** C.

IV. IMPLEMENTATION

1. Dataset: The training and testing requires a sufficiently large number of food images belonging to different categories. We took images from **PFID** (Pittsburgh Fast Food Image Dataset) **[20]** and website of Shutterstock **[21]**. Both of the sources contain more than 5000 images belonging to more than 10 different categories. We collected some data regarding calorie value of different categories from different reliable online sources mentioned in references **[22][24]**and designed a calorie map. We labelled the images alphabetically and divided the images into 5 different categories- Pizza, Burger, Donut, Burrito and Samosa. The dataset is divided into two partitions to have separate training and testing images. The training dataset consists of 3,200 images and testing dataset consists of 648 images.

2. **Pre-processing:** First of all, we did background subtraction operation on all the images used in the dataset. We augmented the dataset by rotating the images 8 times in anticlockwise manner by 45 degrees at a time. We cropped the images to further reduce the background size in order to increase efficiency. This augmented dataset is our final input to the feature extraction algorithm.

3. **HOG (Histogram of Oriented Gradients) feature extraction:** HOG is calculated on each image after scaling the images to 120x120 resolution. We calculated HOG by taking cell size of 5x5 pixels and block size of 3x3 cells. HOG provides a single dimensional vector as feature descriptor. These vectors consist of wide range of values and hence are normalized to change the range of values in the vector. Normalized vector eliminates the effects of image enhancements performed by the device that captured the image. These vectors are saved as **csv** filefor further use.

Input image

Figure 2.1: - feature extraction(HOG)

Histogram of oriented gradients

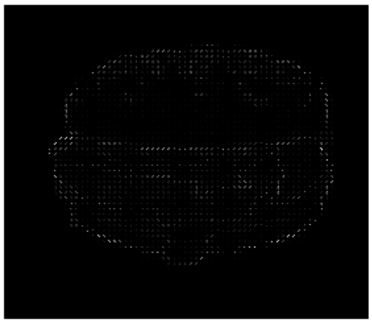

Figure 2.2: - feature extraction(HOG)

4. **SVM (Support Vector Machine) Training:** We used SVM with linear kernel because it provides better results than other kernels. Support Vector Machine works as a learning algorithm and a multiclass classifier and hence we provided the CSV file of the images which contain feature descriptor of the images and provide the number of images belonging to particular category in that order. The classifier creates

 ISSN: 2454-4248
98 – 102

hyperplanes to distinguish among the different classes provided to it and then maps the points in the class they should belong to. The learnt model is saved so that it can be used for testing and reduces the need to run the learning algorithm again and again as it is time consuming.

5. **SVM Learning:** After the learning process, now the model is ready to predict the food item in the image provided to it. But we need to predict either just after the learning process or we can save the learnt model so that it can be used in near future. We preferred the second method. We saved the learnt model as a PKL file and then performed testing and prediction on this on this trained model.
Test dataset need to pass through all the stages that are applied to the training dataset. The testing and prediction phase provides result in different forms. It shows the class predicted for the corresponding food image, gives the percentage accuracy achieved for each class. It also reports the overall accuracy of the model. Result also consists of confusion matrix that shows the number of images and proportion of images predict correctly.

V. RESULT

The systems build earlier**[24]** shows an accuracy level of 72.53%. After completing the whole process of implementing machine learning and testing, we achieved an accuracy of 90.66%.
The results show a good accuracy and support the power of SVM algorithms in pattern recognition. The confusion matrix explains the distribution of images in different categories with the prediction ratio.

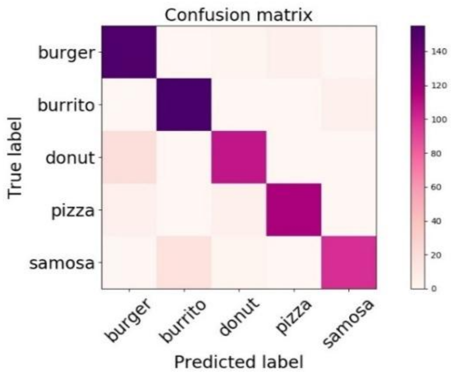

Figure 3:- Confusion matrix

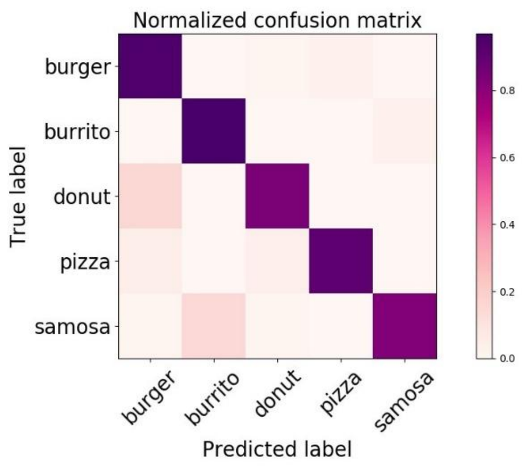

Figure 4:- Normalized confusion matrix

The accuracy achieved for each class of foodis shown below.

Table 1: SVM prediction result

Food-item	Prediction accuracy (%)
Burger	95
Burrito	96.87
Donut	84.37
Pizza	91.40
Samosa	82.5

After identifying the food item with the help of SVM, this result is used to provide the calorie value of food item using the calorie map.

Table 2: calorie table (calorie map)**[22]**

Food item	Calorie content
Burrito	300
Donut	300
Pizza	250
Burger	450
Samosa	308

ISSN: 2454-4248
98 – 102

VI. FUTURESCOPE OF PROJECT

Currently, we were working on a small dataset with less number of classes. The model can be extended to include more categories and more number of images per categories. SVM is a learning algorithm that can further be enhanced by changing its parameter like kernel type and penalty. The result can be further optimized by collaboration of recently designed neural networks that has low complexity and high performance.

VII. LIMITATIONS OF THE MODEL

The model proposed can be used to identify food in the image but it cannot predict hidden ingredients and pieces of food. Also, the model predicts a single food item, a combination of food items cannot be fed to the system.

Reference

[1] George A. Bray and Claude Bouchard, Handbook of Obesity, Second Edition, Ed. Louisiana, USA: ennington Biomedical Research Center, 2004.

[2] Geeta shroff, asimsmailagic, "Wearable context-aware food recognition for calorie monitoring", Wearable Computers, 2008. ISWC 2008. 12th IEEE International Symposium.

[3] World health organization. (2011, october) obesity study.

[4] World health organization. (2012) world health statistics 2012.

[5] National institute of diabetes and digestive and kidney diseases, health risks of being overweight, hlthrisks1104.pdf.

[6] Junqingshang ,ericpepin, ericjohnson, david hazel, ankurteredesai, alankristal, and alexander mamishev, "dietary intake assessment using integrated sensors and software", spiedigitallibrary, pp. 1-11, 2015.

[7] Kavitha s. And pavithra s., "performance analysis of nutritional contents in food images using saran", arpn journal of engineering and applied sciences, pp. Pp.5429-5433, 2015.

[8] Body mass index a better predictor of insulin resistance than waist circumference in normoglycemics, B.L. Preeti, US national library of medicine enlisted journal, ISSN 0974-1143.

[9] Tatsuya Miyazaki, Gamhewage C. de Silva, and KiyoharuAizawa. Image-based calorie content estimation for dietary assessment. In ISM, pages 363–368. IEEE Computer Society, 2011

[10] Mei Chen, K. Dhingra, Wen Wu, Lei Yang, R. Sukthankar, and Jie Yang. Pfid: Pittsburgh fast-food image dataset. In Image Processing (ICIP), 2009 16th IEEE International Conference on, pages 289–292, Nov 2009

[11] Keigokitamura, chaminda de silva, toshihikoyamasaki, kiyoharuaizawa, "image processing based approach to food balance analysis for personal food logging", ieeeicme, pp. 625-630, 2010

[12] Parisa pouladzadeh, gregoriovillalobos, rana almaghrabi, shervinshirmohammadi, "a novel svm based food recognition method for calorie measurement applications", ieee international conference on multimedia and expo workshops, pp. 495-498, 2012.

[13] S. Mingui, L. Qiang, K. Schmidt, Y. Lei, Y. Ning, J. D. Fernstrom, *et al.*, "Determination of food portion size by image processing," in *Proc. 30th Annu. Int. Conf. Eng. Med. Biol. Soc.*, Aug. 2008, pp. 871–874.

[14] L. E. Burke, M. Warziski, T. Starrett, J. Choo, E. Music, S. Sereika, *et al.*, "Self-monitoring dietary intake: Current andfuture practices," *J. Renal Nutrition Off. J. Council Renal Nutrition Nat. Kidney Found.*, vol. 15, no. 3, pp. 281–290, 2005.

[15] J. Beasley, "The pros and cons of using PDAs for dietary selfmonitoring," *J. Amer. Dietetic Assoc.*, vol. 107, no. 5, pp. 739–740, 2007.

[16] Nikhadharman, shafnaps, shahana cm, simishanmughan, nicyjohnson, "img2 calories", international journal of computer trends and technology, pp. 144-148, 2015.

[17] Histogram of Oriented Gradients, scikit-image, image processing in python.

[18] Support Vector Machine, scikit-learn, sklearn.svm.svc, scikit-learn developers, 2017

[19] Support Vector Machine, from Wikipedia, the free encyclopedia.

[20] PFID, Pittsburgh Fast-Food Image Dataset, intel corporation, intel labs Pittsburgh.

[21] Shutterstock fast food images.

[22] Myfitnesspal web service, fast-food calorie,myfitnesspal Inc.

[23] Christopher M. Wharton, PhD; Carol S. Johnston, PhD, RD, Dietary Self-Monitoring, But Not Dietary Quality, Improves With Use of Smartphone App Technology in an 8-Week Weight Loss Trial (J NutrEducBehav. 2014;46:440-444

[24] Calorie estimation from fast food images, KaixiRuan, Lin Shao.