Segmentation of Food Items Using Watershed Algorithm and Predicting the Country of Food Items

A.D.Anantha Padmanabha Reddy, P. Sriramya

ABSTRACT--- ***Performing segmentation on images is a challenging task and interesting task in the field of image processing. Nowadays segmenting the intake of food for every meal and classifying them has become a challenge for user. It is important to assess the food that is taken by people, patients so that they can take of their diet when they fall under any internal diseases. In addition, there exists a problem of eating various kinds of food usually different country food, which actually decreases the resistance of the body etc. Hence, there exists the need to segment the food items and classifying the food items based on country. In addition, the advancement of this can be deployed to evaluate the nutrition content by importing equations in future. However, many existing systems discuss on how to develop an efficient dietary management system and nutrition estimation using various models and algorithms. The food retrieval and classification plays a vital role in every food based dietary management system. In the proposed work, we implement Watershed Algorithm to categorise from a bunch of sample food digital images by performing segmentation analysis and finally displays the unique number of segments whenever there is an overlapping in the food image. In addition, the classification model displays the country with their accuracy through image classification methods. The experimental results shows the accuracy of the classifier model in python and keras tools when different number of epochs are used for the model.***

Key Words: Classification, segmentation, watershed algorithm, identification.

1. INTRODUCTION:

Image Processing actually deals with the process of enhancing some specific operations on a digital image to extract the important information. It is also an emerging technical domain in the current era with wide involvement of various algorithms. It also plays an important role in the assessment of nutrition analysis. There are various tools available to implement Image Processing. Mostly, Mat lab is preferred to implement image processing but it involves many equations to obtain the desired result. The advanced tools used for implementing image processing are opencv and Anaconda.

In the current era, apart from technical need, physical needs like food, shelter are also necessary for every individual. In this world, there exists a huge number of food available, which in turn have a different nutrition content. As the time goes on, the nutrition strategy followed by individuals is getting flat, which results in different diseases. Therefore, there is a need to determine whether a food is nutritious or not. Majorly, the most nutrition content is available in Indian foods. Henceforth, this majorly focuses on how to perform segmentation on an image using watershed algorithm and builds a classifier model to classify an image whether it is Indian food or not.

2. LITERATURE SURVEY:

An unbalanced diet usually causes many issues majorly health issues like over-weight, diabetes and so on. Majorly, it focuses on improving the calorie measurement techniques. It uses the Food Portion Recognition system to measure the calorie and nutrition values. It performs the food portion recognition process by using the method namely Skull Striping and also classification is done by using the Support Vector Machine to determine the calorie in precise manner which helps dieticians and patients effectively. [1]

A dietary assessment system is a foremost upcoming need, which actually traces daily food intake through food images taken during eating process. Food Classification actually involves the special action namely feature extraction and employs the colour descriptors. It actually tests the proposed integrated method on 1453 food images on a whole of 96 unique food items and obtained an accuracy of 34% and 63%. [2]

Convolutional Neural Networks (CNN) based features provides a 79% food and tray recognition accuracy whenever they employed. Using the concepts of sum rule and product rule, it actually calculates the probability for whether a region belongs to a class or not. Tray Segmentation is done where the process of actual segmentation occurs to increase the speed of computation without losing data. For predicting the food label, it employs the use of two classifiers namely k-Nearest Neighbour (k-NN) and Support Vector Machine (SVM). Best food recognition accuracy is achieved using patch based approach on UNIMIB2015 when compared to UNIMIB2016. [3]

Due to the necessities, region growing and region merging methods are employed for performing a food image into multiple segmentation. Using histogram and efficient LBP are used to extract colour and texture features and a radial filter is used with a combination of multiSVM for classification of food items. Proposed methodology starts with the process of CIELAB conversion and performs Pyramidal mean-shift filtering. Radial Basis Function kernel assigns the vector to the segment predefined food classes. [4]

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Mainly the status of food image analysis and the problems attached with the image are needed now a day. Technology Assisted Dietary Assessment System (TADA) addresses the importance of diet and nutrition. A super pixel based normalised cut (SNcut) is designed to reduce the size of affinity matrix in Normalize Cut (Ncut). K-Nearest Neighbours (KNN) is used for colour and texture features and a Vocabulary Tree (VT) classifier used for local features. It addresses that estimating nutrient information from a single image is a challenging problem for research. [5]

For perfection and effectiveness, Comment Analysis is a mandatory task for food recipe preferences. The designed method mainly analyses the end users comments thereby using the concept of polarity words of the food domain. The process of sentiment analysis does comment analysis on food images with the semantic oriented method. The accuracy parameter actually determines whether the results obtained are positively accurate or negative accurate or neutrally accurate using the comparison of actual classes with the corresponding predicted classes. [6]

Calorie determination is so inconvenient and uncomfortable to know before intake of food especially Thai food. In Image Segmentation, usually food area is segmented and texture segmentation is used to segment the food area and mask image creation is done which is actually used to segment the food area. SFTA uses the Two-Threshold Binary Decomposition (TTBD) algorithm for performing the decomposition of the input image. It focuses majorly on amount of calories intake and food image classification. [7]

Due to the advancement of technology, there exists different methodologies in designing dietary assessment system, calorie and nutrition measurement system. It uses nutritional fact tables and captures the food images before and after eating to calculate the nutrient components using a special calibration methodology. A new methodology namely Gabor Filter is employed to measure the local texture components and extracts food images and processes statistical pattern recognition methods. Better accuracy is obtained if food portions are imposing any geometric shapes like circle, triangle, and rectangle and so on. [8]

A mixed combination of features and vocabulary trees for classification actually improves the performance majorly food classification performance with a count of 22% for Top 1 classification accuracy and 10% for Top4 classification accuracy. The combination of three features namely SCD, DCD and MDSIFT improves the food classification accuracy by 22% and Top 4 classification accuracy by 10%. It concludes that recognising of every kind of food is impossible. [9]

The most deciding parameter, weight cannot be determined easily in every case, even more complex in the case of determining weight of bars. A combination of image segmentation technique and image dimension, density based formula object weight is determined. It prefers watershed algorithm through mat lab to perform image segmentation. It works well for 2D images using image processing but does not provide absolute accuracy, which can be improved by Conventional weighing methods. [10]

On a whole, a mixed combination of Intensity and Texture based image segmentation provides accurate results instead of traditional methods. It focuses on various segmentation techniques and describes about technique in short like identifying edge, region depends upon pixel. It returns values in between zero and one for likely edges. Convex Energy Function is used by contour model to predict the boundaries and uses Local Gaussian Distributing Fitting (LGDF). [11]

Finally, I conclude the work of the whole literature survey based on the functionalities they deployed as shown in the Table 1

TECHNIQUES	AUTHOR	YEAR	PERFORMANCE	DATASET
Adaptive FCM	Cao et al	2012	Classical FCM employs the gain field model to correct the intensities by microscope imaging methods	M-Fish dataset
Local Variation, Descriptors	Ye He, Chang Xu	2013	Performs a stabilised segmentation using a mixture of Image segmentation and classification which increases the resultant accuracy by 34% and 63%	Regular and Irregular Food Images
SFTA,TTBD algorithm, colour histograms,SVM	Natta Tammachat, Natapon Pantuwong	2014	It evaluates the calories content in Thai food image and recognize the corresponding food image using SVM.	Thai Food images
Comment analysis, sentiment analysis, semantic oriented approach,	Pakawan Pugsee, Monsinee Niyomyanich	2015	It classifies the user entry comments into different categories like positive and negative. In addition, it predicts the percentage of accuracy of the categorised sectors.	Food recipes
Convolutional Neural Network, k-Nearest Neighbour, Support Vector Machine	Gianluigi Ciocca	2016	It performs the TRAY analysis on the images and increases the computation speed by using tray segmentation. Patch based approach is done to achieve high food recognition accuracy	UNIMIB2016 dataset
Skull Striping, Support Vector Machine, Fuzzy C Means Clustering	Ankita A. Podutwar	2017	It uses the food portion recognition method to calculate the calorie and nutrition values. It employs the RBF kernel to map samples	Food Images
Local Binary Patterns, region growing, region merging method, CIELAB conversion	Priyadarshini.C.Patil	2018	Hierarchial model of k-means algorithm is employed to perform clustering and LBP is used for text features and accuracy of 96% and sensitivity of 93.3% is achieved	South Indian Food images

Table 1: Methodology Comparison

3. PROPOSED SYSTEM:

The designed method involves a real time segmentation concept i.e. watershed segmentation algorithm. The methodology used clearly explains the complete analysis of watershed algorithm on images in opencv. Even more, it provides the level of unique segments, which is not provided by algorithms like semantic, Instance segmentation. In addition, the methodology used actually creates a classifier model on the dataset provided. After the construction of model, any image is fetched to test with the proposed model to obtain the results.

a. Watershed algorithm:

Step-1: Getting an input test image from the designed dataset.

Step-2: Performing pyramid mean shift filtering on the test image.

Step-3: Conversion of mean shift image to grayscale image.

Step-4: Application of Otsu thresholding.

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Step-5: Computation of Euclidean distance and Exploration of peaks.

Step-6: Application of watershed segmentation of algorithm to find the number of unique segments.

b. Classifier model:

Step-1: Creating our own dataset.

Step-2: Defining the network architecture and constructing keras image classifier.

Step-3: Training the designed neural network image classifier and saving the model.

Step-4: Plotting the loss and accuracy curves for the designed model.

Step-5: Evaluating the designed neural network image classifier.

3.1 ARCHITECTURE:

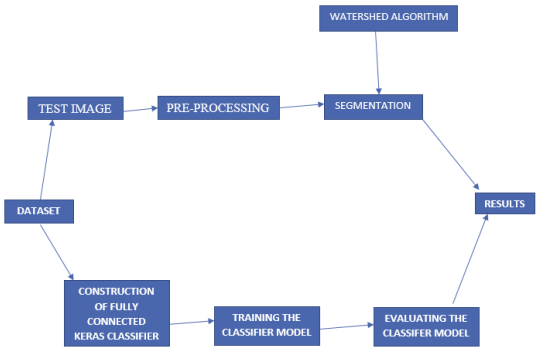

Figure 1: System Architecture

The above architecture helps us to understand more clearly how the information will flow step by step and the pictorial view of the idea represented in this paper.

3.2 RESULTS:

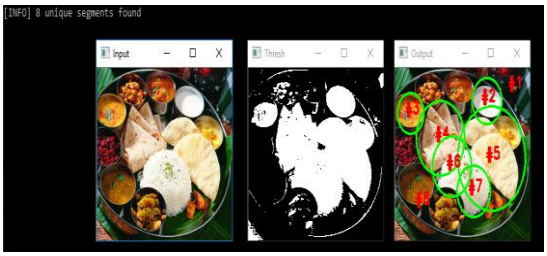

Figure 2: Segmentation of food image

The above image displays the result of watershed algorithm, which is applied to the input test image. It displays the number of unique items, which are overlapped with each other.

Figure 3: Classifies the food image as Indian

The above image describes that the input test image, which is tested with the classifier model, comes under the category of Indian Food with 82.17%.

Figure 4: Classifies the American food image as Not Indian Food

The above image describes that the input test image (American Food) which is tested with the classifier model comes under the category of Not Indian Food with 55.18%.

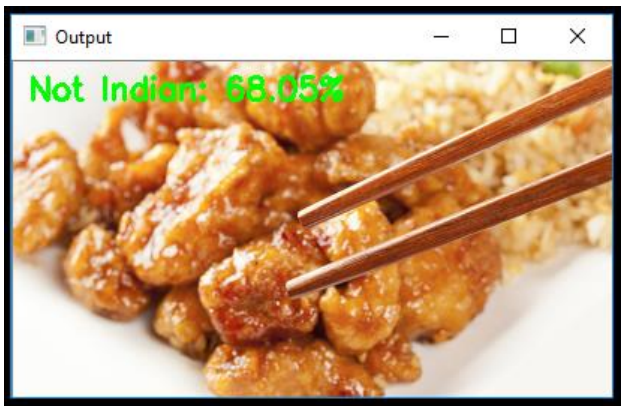

Figure 5: Classifies the Chinese food image as Not Indian Food

The above image describes that the input test image (Chinese Food) which is tested with the classifier model comes under the category of Not Indian Food with 68.04%.

The following tables' shows the accuracy and loss values for every epoch based on total number of epoch chosen. The corresponding graph is also plotted for the dataset, which is selected for training the model

Epoch No	Time	Loss	Accuracy	Val_loss	Val_acc
1/20	206ms/step	0.7785	0.5781	0.6513	0.6744
2/20	116ms/step	0.6511	0.6506	0.6428	0.6744
3/20	116ms/step	0.6547	0.6268	0.6574	0.6744
4/20	115ms/step	0.6747	0.6348	0.6685	0.6744
5/20	115ms/step	0.6672	0.5668	0.6590	0.6744
6/20	115ms/step	0.5747	0.6948	0.7425	0.6744
7/20	116ms/step	0.5425	0.7027	0.8896	0.6744
8/20	114ms/step	0.6324	0.5946	0.6618	0.6163
9/20	125ms/step	0.5737	0.6591	0.8635	0.6744
10/20	121ms/step	0.6221	0.6562	0.6570	0.6047
11/20	114ms/step	0.6077	0.6427	0.7350	0.6628
12/20	114ms/step	0.6188	0.6144	0.6622	0.5814
13/20	113ms/step	0.5277	0.7225	0.8613	0.6395
14/20	113ms/step	0.6398	0.6625	0.6615	0.5698
15/20	113ms/step	0.6479	0.6750	0.7369	0.6744
16/20	114ms/step	0.5747	0.6589	0.6391	0.6744
17/20	115ms/step	0.6102	0.6427	0.6774	0.6628
18/20	125ms/step	0.5551	0.6427	0.6941	0.6628
19/20	120ms/step	0.5532	0.6523	0.7470	0.6395
20/20	113ms/step	0.5831	0.7186	0.7259	0.5930

Table 2: Loss/Accuracy values when epoch=20

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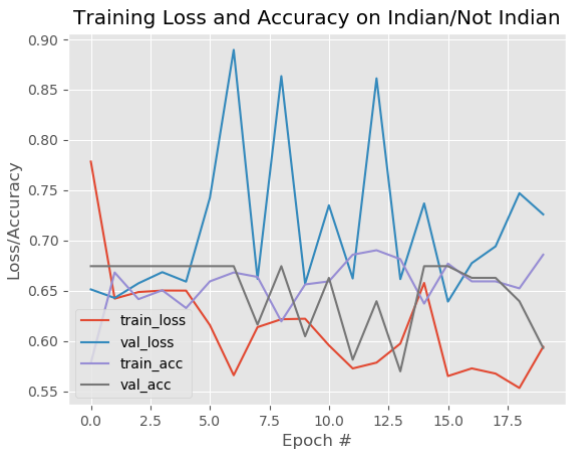

Figure 6: Loss/Accuracy curve when epoch=20

Epoch No	Time	Loss	Accuracy	Val_loss	Val_acc
1/25	211ms/step	0.7702	0.5742	0.6300	0.6744
2/25	117ms/step	0.6849	0.5906	0.6368	0.6744
3/25	116ms/step	0.7120	0.5549	0.6583	0.6744
4/25	116ms/step	0.6258	0.7106	0.6748	0.6744
5/25	116ms/step	0.6469	0.6308	0.6427	0.6744
6/25	117ms/step	0.6094	0.6750	0.6999	0.6744
7/25	116ms/step	0.6196	0.6427	0.6529	0.6744
8/25	116ms/step	0.5879	0.6869	0.7683	0.6744
9/25	127ms/step	0.6104	0.5906	0.6514	0.6047
10/25	123ms/step	0.6235	0.6328	0.8404	0.6744
11/25	116ms/step	0.6069	0.6387	0.6550	0.6047
12/25	115ms/step	0.6404	0.5867	0.7142	0.6047
13/25	115ms/step	0.6433	0.7305	0.6626	0.6744
14/25	115ms/step	0.6790	0.6229	0.6809	0.6744
15/25	114ms/step	0.6711	0.6308	0.6366	0.6744
16/25	115ms/step	0.6526	0.6506	0.6383	0.6744
17/25	119ms/step	0.6852	0.5668	0.6473	0.6744
18/25	132ms/step	0.6573	0.6467	0.6594	0.6744
19/25	133ms/step	0.6244	0.6484	0.6432	0.6744
20/25	116ms/step	0.6029	0.6869	0.7146	0.6744
21/25	116ms/step	0.6096	0.6308	0.6535	0.6628
22/25	114ms/step	0.6253	0.7067	0.7005	0.6744
23/25	114ms/step	0.5333	0.7067	0.6593	0.6163
24/25	114ms/step	0.6054	0.6586	0.6672	0.6047
25/25	114ms/step	0.5993	0.6506	0.6551	0.5814

Table 3: Loss/Accuracy values when epoch=25

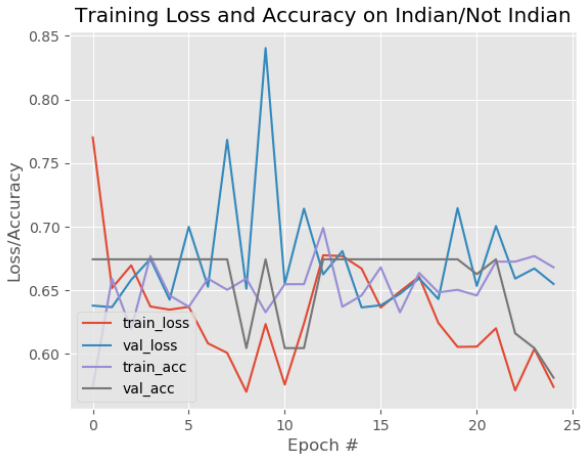

Figure 7: Loss/Accuracy curve when epoch=25

Epoch No	Time	Loss	Accuracy	Val_loss	Val_acc
1/30	225ms/step	0.6858	0.6445	0.6614	0.6744
2/30	115ms/step	0.6455	0.6387	0.6523	0.6744
3/30	114ms/step	0.6753	0.6308	0.6472	0.6744
4/30	114ms/step	0.6321	0.6908	0.6402	0.6744
5/30	114ms/step	0.5962	0.6869	0.7904	0.6744
6/30	113ms/step	0.6601	0.5787	0.6777	0.5698
7/30	115ms/step	0.6306	0.6665	0.7685	0.6744
8/30	114ms/step	0.6337	0.6670	0.6516	0.6744
9/30	133ms/step	0.6661	0.5867	0.6383	0.6744
10/30	129ms/step	0.5998	0.6523	0.6495	0.6744
11/30	119ms/step	0.6477	0.6506	0.6422	0.6744
12/30	118ms/step	0.6583	0.5312	0.6458	0.6628
13/30	119ms/step	0.5332	0.7022	0.7170	0.6628
14/30	116ms/step	0.6469	0.5787	0.6623	0.5698
15/30	114ms/step	0.5947	0.6750	0.7023	0.6512
16/30	114ms/step	0.5425	0.7265	0.8675	0.6512
17/30	115ms/step	0.5966	0.6467	0.6838	0.5000
18/30	125ms/step	0.6309	0.5713	0.7995	0.6395
19/30	124ms/step	0.6279	0.6094	0.6691	0.5930
20/30	114ms/step	0.5903	0.6427	0.7447	0.674
21/30	114ms/step	0.5624	0.6467	0.7533	0.6512
22/30	113ms/step	0.6775	0.6348	0.6815	0.5349
23/30	115ms/step	0.6107	0.7067	0.6724	0.6628
24/30	113ms/step	0.6558	0.6104	0.6793	0.5698
25/30	112ms/step	0.6130	0.6789	0.7208	0.6744
26/30	113ms/step	0.5914	0.6704	0.7298	0.6395
27/30	125ms/step	0.5732	0.6625	0.7167	0.5930
28/30	121ms/step	0.5572	0.6836	0.8524	0.6047
29/30	114ms/step	0.5984	0.7225	0.7131	0.3837
30/30	115ms/step	0.6472	0.6150	0.6710	0.6163

Table 4: Loss/Accuracy values when epoch=30

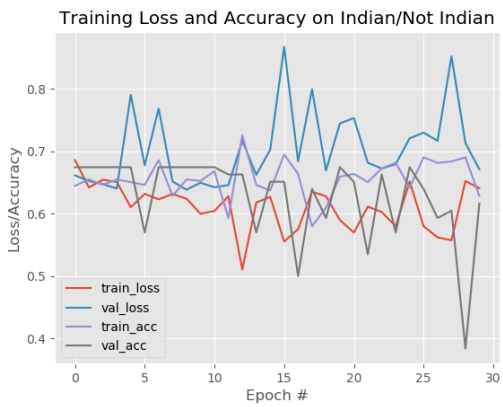

Figure 8: Loss/Accuracy curve when epoch=30

4. CONCLUSION:

The developed model is trained on a dataset of around 300 images. Therefore, the result obtained is medium but not too high. The designed model successfully gives an accuracy of 61.6% as a whole when epoch is 30. Similarly, the designed model gives an accuracy of 58.1% as a whole when epoch is 25 and displays an accuracy of 59.3% when epoch is 20. Thus, the trained model can be improved further by expanding the dataset so that there will be an increase in accuracy. Similarly, increase in pixels will in turn increase the accuracy, probably 64 * 64 pixels is suggested. Henceforth, the result obtained by applying watershed algorithm identifies the unique segments when there is an overlapping of items. Since, the dataset contains the Indian food images and not Indian food images contains the American and Chinese food items, the model which is trained on the dataset uniquely identifies the input test image as Indian or not Indian.

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