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Calorify: Calorie Estimation System Using Object Detection by Deep Learning Technique

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Abstract

In last decade or two, an incremental growth in obesity has been witnessed all around the world. There has been increasing research in order to tackle obesity using food logging and food image calorie analysis. These researches allow users to monitor their calorie intake which helps promote healthy living. This paper explores the use of image analysis techniques to ascertain a more accurate calorie count from photographs and images of food items. The methods employed involves determining the calorie count of the food item through mathematical calculations of the features extracted from food image by using deep neural networks. In this paper, we propose a mobile software for food calorie estimation from pictures of food plates. By using YOLO [6] (You Only Look Once- Object detection using deep learning algorithm), we are able to detect the food and thereby calculate the required food calories from the diverse datasets of Indian cuisine.

Keywords*— *object detection, calorie estimation, deep learning, YOLO

I. INTRODUCTION

In order to bring calorie awareness among health-conscious people, this paper produces a mobile application that gives the calorie estimates from the photos of the meals specifically focussed around Indian Cuisine. The application determines the calorie count of the all the food items detected on the plate at the time of taking the photo through mathematical calculations [2] of the features extracted using the feature extraction methods. From the overly ranged food items of the Indian Cuisine, we have picked up six items which are roti, sabji, rice, daal, puri and Gulab jamun, to be the standard dataset on which the model will be trained to perform prediction. The techniques that we have employed are object detection, object classification, feature extraction and calorie calculation.

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II. RELATED WORK

In recent years many researches have been done in the field of calorie estimation to encourage the healthy lifestyle of people across the world. The common thing in these researches was that they were majorly concerned with the fast foods. In contrast our paper is focused on Indian cuisine that is basic for common Indians.

In [1] Tatsuya Miyazaki at el. had discussed an image analysis-based approach to calorie count estimation for dietary assessment. They had built a dataset of almost 6000 images contained in food log calorie count of which had been estimated by nutritionist. The food image was compared with food log dataset from the perspective of multiple features such as Correlograms, colour Histograms and SURF features.

In [3] Manal Chokr at el. proposed a way to estimate the calorie content of the food item (pointed towards eatables like pizzas, doughnuts, chicken, sandwiches) by measuring the size of the item by passing the compressed image through a regressor.

In [4] proposed a system where users were allowed to manually draw around the boundaries of the food image using tools and after that the drawn section was compared with the dataset to provide the calorie content of the food item with an upper hand in accuracy.

In [5] Parisa Pouladzadeh at el. had presented a food calorie and nutrition measurement system that helped patients and dietitians to manage daily food intake. The paper proposed to build a mobile application that will provide the measure of calorie and nutrition contents by clicking the photo before and after the consumption of food

III. DATASETS AND METHODS

A. Datasets

For our paper, annotated images of the Indian meal were required. For this we extracted custom dataset from images.google.com and labelled the images using labelImg. Our custom dataset contains 500 annotated images of 6 classes and split 2/3 and 1/3 in train and validation dataset. 6 classes of the dataset being Bhaji(vegetable), Dal(curry), Rice, Roti, Puri and Gulab Jamun.

A.1 CNN (custom dataset)

We performed binary classification on custom dataset of the Indian Roti which helped us predict a given image to be a Roti or not. In this we used a total of 200 Roti and non-roti images.

A.2 YOLO V2 (COCO dataset)

We used the COCO dataset to train the YOLO model first. It contains 80 object classes such as person, laptop, apple, etc. With 35000 images in the dataset with train, valid, test split in 1/2,1/4,1/4 respectively. Annotations being in XML and text format.

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A.3 YOLO V3 (custom dataset)

Our custom dataset contains 500 annotated images of 6 classes and split 2/3 and 1/3 in train and validation dataset. 6 classes of the dataset being Sabji (vegetable), Dal (Indian curry), Rice, Roti, Puri and Gulab Jamun.

B. Methods

The first step in our project is to register a plate and a reference object which will be a 1-rupee or 2-rupee or 5-rupee coin and by using OpenCV modules we will calculate the dimensions of the plate that will be further used to give the calorie count of the food item. For the food detection we are using YOLO (You Only Look Once) which is a deep learning algorithm. The dataset will be labelled and trained according to the YOLO format and after the food detection the counted. For all the items except for rice we will be using standard calorie values and for rice we will calculate the area of it and eventually we will get the calorie count through mathematical computations. The formula for the area calculation that we are using is: **Fr = Sr * (Fp /Sp)** where,

- Fr: area of target food item.
- Fp: the area of the registered plate.
- Sp: the pixel count of the whole registered plate.
- Sr: the pixel count of the region of the target food item.

After getting the calorie counts of each item the aggregated calorie count of the meal will be presented to the user.

B.1 Process of reference object registration

With the reference of the dimensions of the coin which is already known, we will get the dimensions of the plate through OpenCV modules such as scipy, argparse, imutils, numpy, cv2 etc.

Fig.1 Process to register the plate with reference object

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IV. PROPOSED SYSTEM

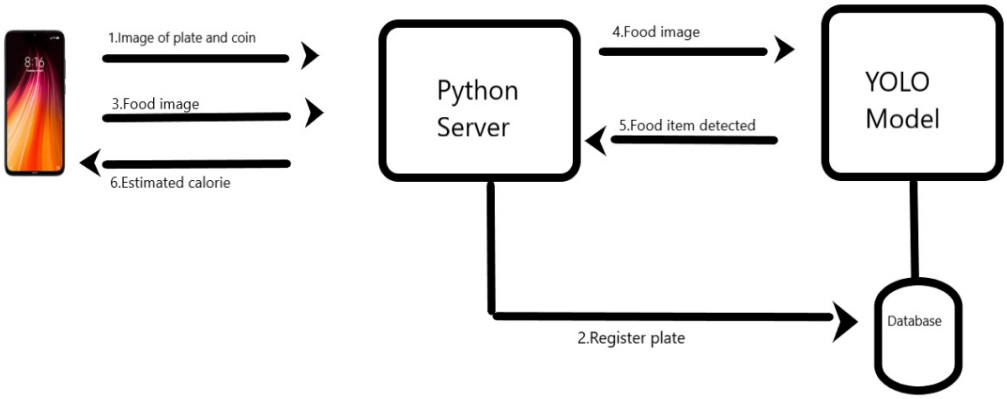

Fig.2 System Architecture

V. SOFTWARE AND HARDWARE REQUIREMENT

The YOLO model is trained on the machine having 8GB (Gigabytes) of RAM and 2GB of VRAM. In this system two programming languages are used namely, Python and Java. The YOLO framework consists of Darknet layers. YOLO uses many Python libraries wiz. NumPy, OpenCV, Pandas, etc. Whereas for the GPU or VRAM CUDA drivers are used. YOLO model is saved as collection of various entities listing: a Neural Network Model, a custom Configuration file and trained Weights. Java is used for Android application.

VI. LABELLING AND TRAINING

For labelling purpose, we have used the LabelImg tool which is a tool for graphical image annotation. In LabelImg, annotations of each image were saved as an XML file in PASCAL VOC format.

With regards to the training of our model we used Google Colab, a Jupyter notebook environment which runs on cloud without any setup. We have trained YOLO with Darkflow in Google Colab. Darkflow is a Darknet adapted network builder. It allows building TensorFlow networks from cfg(configuration file format) files and loading pre-trained weights. We used it to run YOLO on our configured layers and the dataset.

Here is an image that we used to test our trained model.

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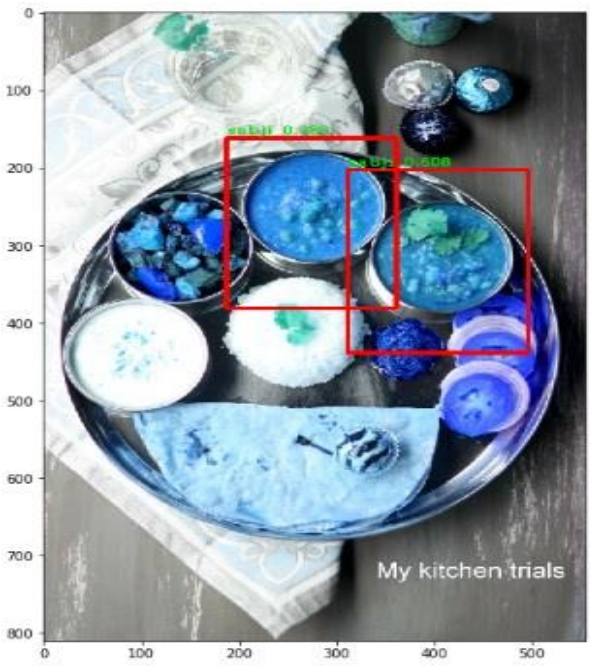

Fig.3 A test image used to test our trained model

VII. RESULTS

At first, we performed a binary classification on custom dataset of the Indian Roti using Convolutional Neural Network (CNN) which helped us predict whether a given image was a Roti or not. Since this algorithm helped us only in classifying different food items but we were not able to detect where that item was located in the image, we used YOLO which did the classification and detection of multiple objects simultaneously.

The Mean Average Precision (mAP) of the CNN model was found out to be 86.89 whereas in case of YOLO [v3] trained on custom dataset it was 81.00. We can see that the CNN model is more precise but we prioritized speed over precision. Therefore, we chose YOLO over CNN as it turned out be fast.

TABLE I MODEL ACCURACY

Sr.No.	**Model evaluation**		
	Algorithm	**Dataset**	**Mean Average Precision (mAP)**
1	CNN	Custom dataset (binary set of roti or not_roti)	86.89
2	YOLO [v3]	COCO	90.92

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		dataset	
4	YOLO [v3]	Custom dataset (Indian food items)	81.00

VIII. CONCLUSION

In this paper, we have proposed a calorie count estimation system which runs on a user's smartphone. The system estimates food calories automatically by simply taking a picture of the food items placed in the thali (which is precisely taken to be the standard Indian thali). The dataset includes Roti, Puri, Dal, Rice, Sabji and Gulab Jamun derived from the typical Indian thali. The scope is limited to the Indian thali dataset.

Thus, the project helps in giving the righteous number of calories to the user which will surely help in keeping track of the total calorie intake.

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