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Direct calorie classification of West African dishes with a small dataset

DJANGORAN EZOA A M *1 KIKUCHI MASATO*2 OZONO TADACHIKA*3

*1*2*3Nagoya Institute of Technology

Diabetes, obesity, and high blood pressure are becoming common diseases that the African healthcare system is fighting. These diseases have been linked to a diet that is often either too rich or too poor in certain nutrients. In addition, many Africans want to track their diet to lose weight or stay healthy, but they struggle to find an application or a good dataset with information on the daily dishes and calories that are specific to their cuisine. This paper proposes a new, direct, real-time calorie rating system for daily dishes in West Africa. Our first study was conducted on 11 types of Ivorian daily dishes, using a dataset of 636 images. Our first baseline system groups dishes into calorie classes (high, medium, and low) and use YOLOv5 (You Only Look Once) for dish detection and calorie classification, with a small amount of data. With 88.8 % of accuracy, our model can be used in mobile applications to support the African healthcare system, which suffers from a lack of dieticians.

Keywords: West African dishes, calorie classification, calorie estimation, food recognition.

1. Introduction

Dish recognition and classification is a challenging research area that can help people in their daily lives. Automatic daily dietary monitoring has become very important and necessary to track what people eat on a daily basis and find solutions to help them with various diet-related diseases like obesity, diabetes, and blood pressure, collectively known as non-communicable diseases. Most of the time, in West Africa, indigenous people, foreign workers, or tourists who want to monitor their diets and eat local dishes have to find information about the amount of calories in each dish themselves, because it is not provided by the restaurant and there is no official website that provides this information. However, with cutting edges technologies such as artificial intelligence, especially computer vision, we can train the computer to quickly learn patterns within a collection of images. How can we use computer vision technology to quickly provide calorie information for West African dishes?

2. Related work

The growth in the number of people affected by diseases caused by an unhealthy diet has led researchers to study the problem from different aspects, utilizing new technology. Pouladzadeh & al.[1] proposed a food calorie measurement system using a deep learning neural network. This assistive calorie measurement system is designed to help patients and doctors in their fight against diet-related health conditions. Calorie estimation using deep learning can be done with a neural network that is trained to predict the calorie content of a food item based on its characteristics. These characteristics can include factors such as the type of food, serving size, ingredients, and cooking directions. Takumi Ege & al.[2] proposed a method which used convolutional neural network (CNN) for food detection and calorie estimation. Their approach was to realize a multi-task learning of dish detection and food calorie estimation with a single CNN. However, there was no dataset with both annotated bounding boxes and food calories for each dish, they used two datasets for multi-task learning. Their technique was specifically focused on Japanese food, and due to the lack of calorie-annotated multiple dishes datasets, they could not evaluate the performance of their system. Their system runs on a smartphone and allows the user to take a picture of the food and measure the amount of calorie intake automatically. However, this system can only identify a single food portion. Koichi & al.[3] proposed a system based on an automatic calorie estimation system for food images. They carried out food region segmentation and used reference objects for food calorie estimation. Despite these research efforts, many of them have been conducted in regions where there are known datasets of dishes and calories, and where the dishes are separated on the plate.

Contact: DJANGORAN,ezoa@toralab.org

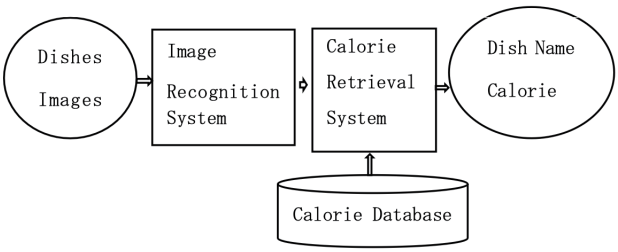

Figure 1: Calorie estimation architecture 1

3. System description

In the first attempt of realizing our system (Figure 1), we made its architecture a combination of a YOLO (You Only Look Once) and a calorie database, which includes the names of dishes and their corresponding calories amounts. YOLO is one of the fastest models for object recognition. It is a real-time object recognition algorithm that processes images very quickly. Its architecture considers the entire image and includes all contextual information, and it even uses image features to make better predictions. In our

Table 1: Dataset of common Ivorian dishes.

#	Dishes names	Kcal/100g	Images
1	peanut sauce	588	78
2	seed palm sauce	830	83
3	pistachio sauce	617	50
4	tomato sauce	29	40
5	chicken kedjenou	220	79
6	alloco	252	92
7	attieke	350	81
8	foufou	181	34
9	damn yam	111	24
10	placali	100	27
11	damn banana	169	48
Total			636

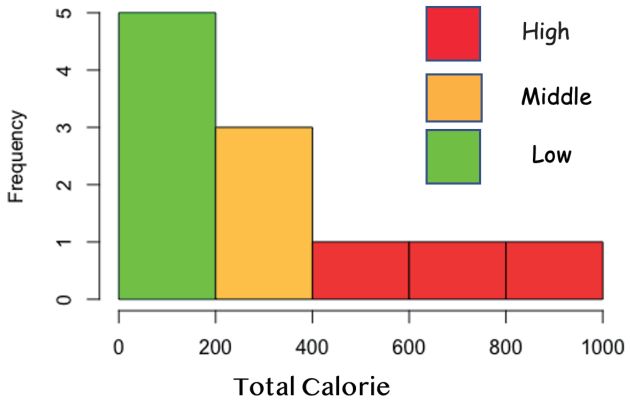

Figure 2: Histogram of calorie repartition

study, we focused on 11 popular daily meals in Cote d'Ivoire (Table 1) and collected 636 images from the Internet. We obtained the average calorie content of each of these meals. It is often difficult to find information on the calorie content of Ivorian dishes since they are typically served in combination with sauces, meat, or fish, and side dishes such as yam, plantain, or cassava semolina in the same plate. Therefore, our database only contains calorie information for sauces and side dishes that do not include protein, such as meat or fish. The difficulty with our first architecture system was the fact that YOLO could not accurately recognize each dish in the picture containing several dishes. Based on (Table 1), we grouped the energy values in calories of the different dishes into three classes: low values ranging between 0 and 199, intermediate (Middle) values ranging from 200 to 399, and high values starting from 400 (Figure 2). To address the difficulty of accurately recognizing each dish in a picture with multiple dishes, we proposed a new architecture (Figure 3) that uses only the YOLO model to display the amount of calories in dishes.

4. Experiment and discussion

We divided the image dataset into 402 training data, 130 validation data, and 104 test data. Additionally, we performed data augmentation on the training data by flipping

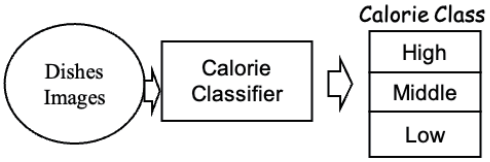

Figure 3: Calorie estimation system 2

Table 2: Training result of architecture 2. P : precision,R : recall, mAP : mean Average Precision .

#	class	P	R	mAP50	mAP50-95
0	all	88.8	93.9	94.9	59.5
1	High	92.6	98.1	97.7	64.5
2	Low	84.9	90.7	92.4	55.9
3	Middle	89.0	93.0	94.4	58.1

horizontally, rotating by -15 and +15 degrees, adjusting saturation by -25% to +25%, and creating mosaics to obtain a total of 1200 images. After training the YOLOv5 model for 200 epochs, we achieved a precision of 88.8% (Table 2). Our study aims to classify West African dishes by their calorie content using a small amount of image data. Our model achieved a high accuracy (P) of 88.8%, which means it has a low number of false positive results. The recall (R) value of 93.9% indicates that our model has a low number of false negative results. The mean average precision 50 (mAP50) value of 94.9% demonstrates our model's ability to accurately predict bounding boxes. However, our system is limited to recognizing only 3 classes of calories, which contain 11 dishes. To improve our model's recognition performance, we will add a reinforcement learning module. To estimate calorie content, we plan to use image segmentation to identify patterns between dish colour and calorie value. For model training, we plan to implement continuous machine learning training. To expand our image dataset, we intend to integrate our model into mobile apps and save images of dishes after recognition.

5. Conclusion

By grouping the calories of the 11 dishes into 3 classes, our system is able to produce more accurate results of calorie estimation using less data. Our system can be implemented in mobile apps, and we can provide fast and reliable calorie information for West African dishes.

References

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