

A New Large-scale Food Image Segmentation Dataset and Its Application to Food Calorie Estimation Based on Grains of Rice

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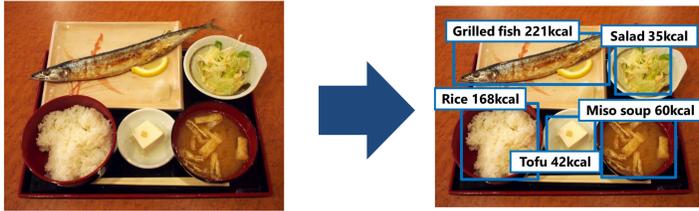
Background

Some meal recording app can estimate food calories.

But they ...

- Need user's manual input of food categories and volumes.
- Estimate food calories for each dish one by one.
- Are paid service to hire nutritionists who estimate food calories.

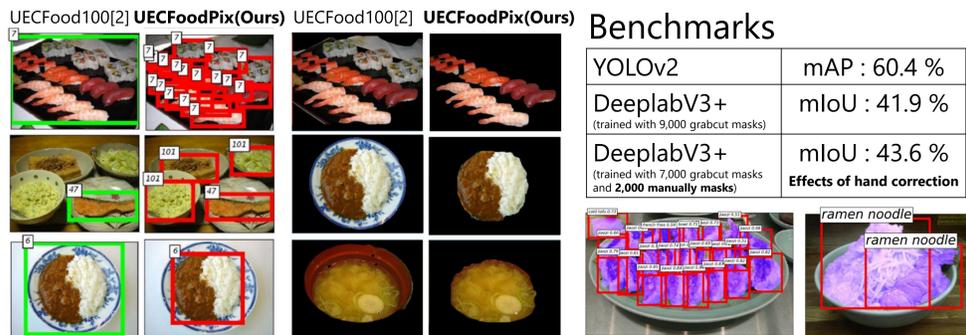
Purpose : Image-based food calorie estimation



New Dataset : UECFoodPix

- Annotated new instance-based bounding boxes to 10,000 images included in UECFood100 [2] manually.
- Annotated segmentation masks to 9000 images automatically by GrabCut, and 1000 images manually for the evaluation.

※ We will publish the dataset as soon as all images are corrected by hand.



Benchmarks

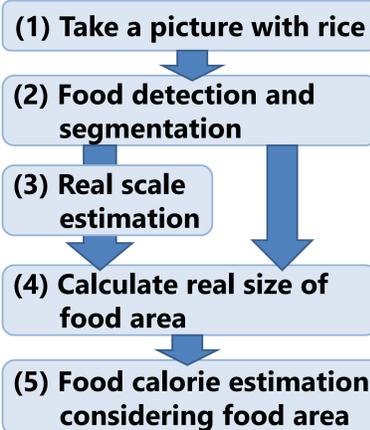
YOLOv2	mAP : 60.4 %
DeeplabV3+ (trained with 9,000 grabcut masks)	mIoU : 41.9 %
DeeplabV3+ (trained with 7,000 grabcut masks and 2,000 manually masks)	mIoU : 43.6 %

Effects of hand correction

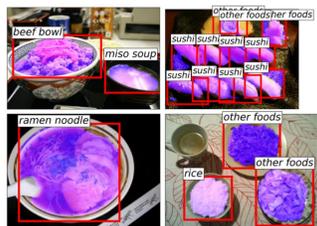
Method : Food calorie estimation considering food area

The procedure of food calorie estimation

- (1) Take a food photo with rice.
- (2) **CNN-based Food detection and food segmentation for each dish .**
- (3) **Estimate real scale from rice grain images.**
- (4) Calculate real size of food area from both estimated real scale and segmentation masks.
- (5) **Estimate food calories based on estimated food area size and category-dependent calorie density.**



(2) Food detection and segmentation



YOLOv2 [3] trained with UECFOODPix
U-Net [4] trained with UECFOODPix's binary masks (mIoU : 84.1%)

UECFOODPix enables highly accurate food detection and segmentation.

(3) Real scale estimation from rice grain images



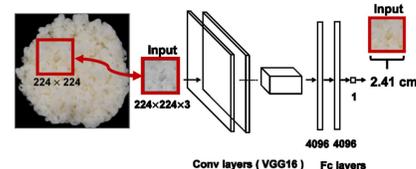
Rice image dataset

Annotated with **real scale** and **segmentation masks**. A total of 360 rice images were taken in our laboratory.

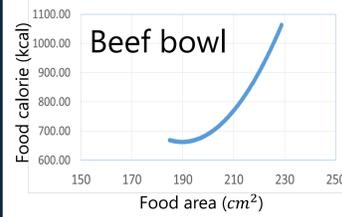
Real scale estimation

Takes a rice grain image as an input and outputs the real size of the length of one side of the input image.

CNN enables real scale estimation robust to the size and orientation of rice grains



(5) Calorie estimation considering food area size



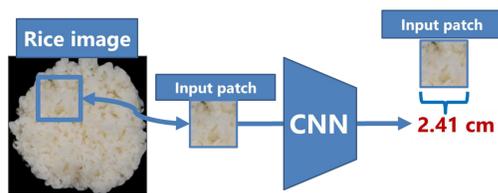
Use quadratic curve based estimation[1]

$$calorie = a_i * size_{food}^2 + b_i * size_{food} + c_i$$

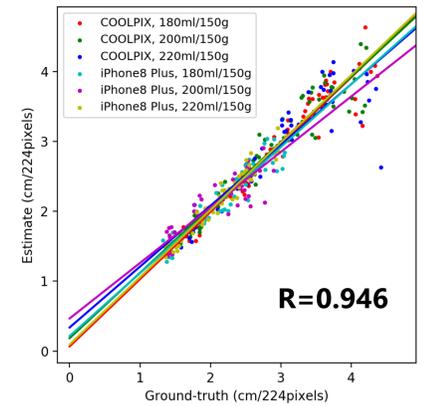
Where a_i, b_i, c_i are trained params for each i -th categories.

Experiments

1. Real scale estimation from rice grain image

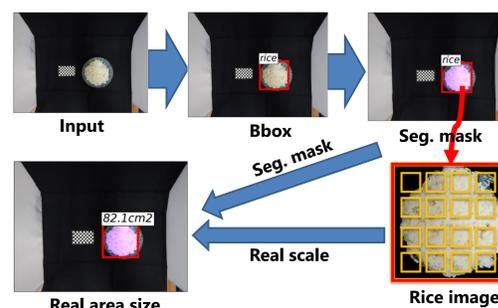


Absolute err. (cm/224pixel)	0.145
Relative err. (%)	5.548
Correlation	0.946

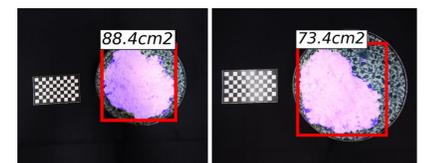


The correlation coefficient between the estimation and ground-truth is 0.946

2. Real area estimation from rice grain image



Examples



	GrabCut	U-Net
Absolute err. (cm^2)	14.2	13.3
Relative err. (%)	15.0	13.9
Correlation	0.469	0.474

3. Food calorie estimation considering food area

Examples



Conclusion

Real scale estimation



Segmentation, 3D



We proposed

- New Large-scale Food Image Segmentation Dataset
- Food calorie estimation considering food area.

In the future work, considering food volumes even when there is no rice, we are considering

- Combining the method which employed segmentation and a reference object
- Using the depth information obtained from the camera of iPhone

[1] K. Okamoto and K. Yanai. An Automatic Calorie Estimation System of Food Images on a Smartphone, MADiMa, 2016 .
[2] Y. Matsuda, H. Hajime, and K. Yanai. Recognition of multiple-food images by detecting candidate regions. ICME , 2012 .
[3] J. Redmon, A. Farhadi , YOLO9000: Better, Faster, Stronger, CVPR 2017.
[4] O. Ronneberger, P. Fischer, and T. Brox. U-net: Convolutional networks for biomedical image segmentation. MICCAI, pp.234-241,2015 .