# DepthCalorieCam: A Mobile Application for Volume-Based Food Calorie Estimation using Depth Cameras

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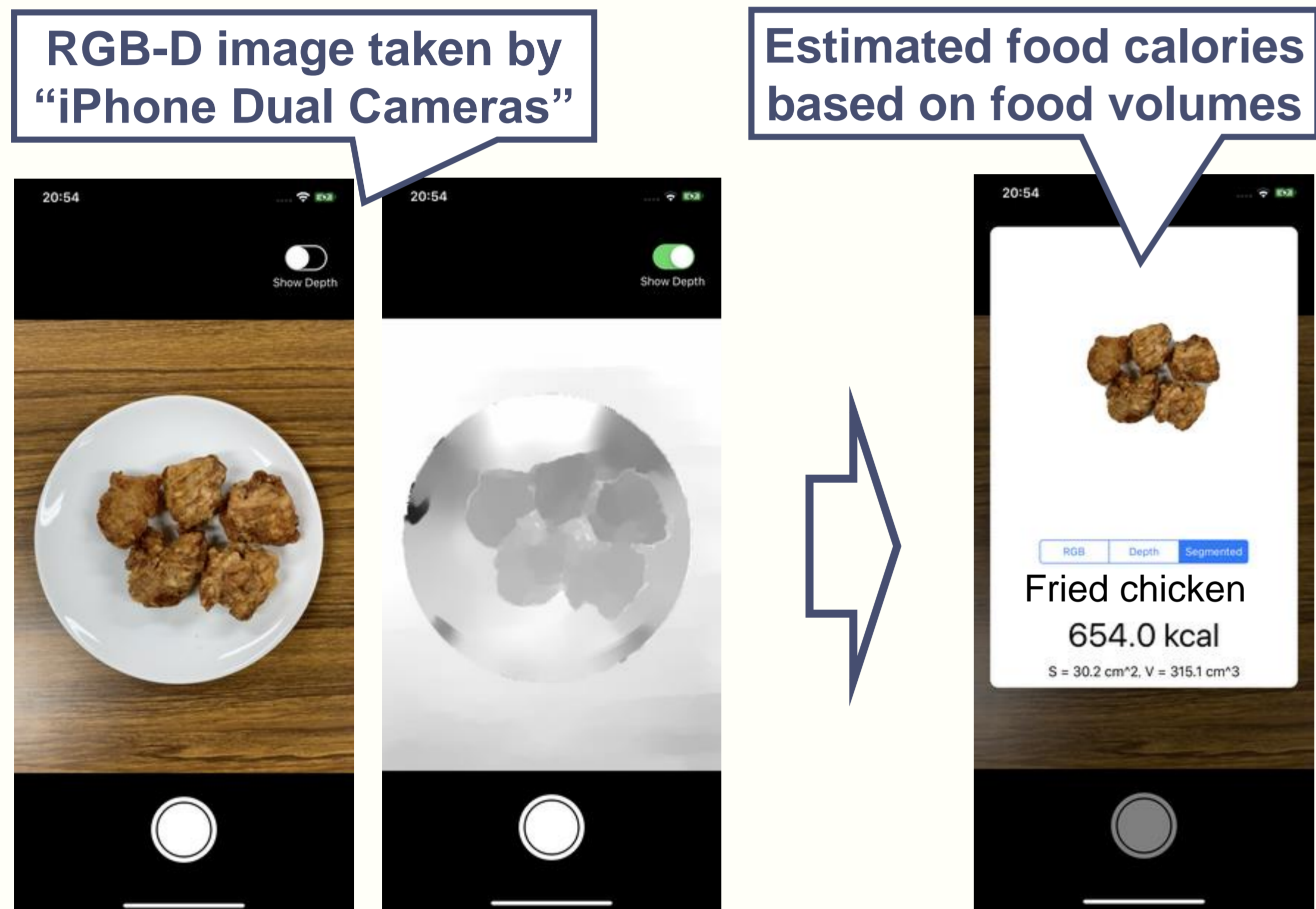The University of Electro-Communications, Tokyo

## Objective

The increased demand for food calorie estimation using smartphones

But they…
- Ask users to provide the size of dishes
- No care about the volumes of foods

### Food calorie estimation just by taking a picture !!

**RGB-D image taken by "iPhone Dual Cameras"**

**Estimated food calories based on food volumes**

Fried chicken
654.0 kcal
S = 30.2 cm*2, V = 315.1 cm*3

### DepthCalorieCam

**Demo app is published**

Download on the App Store
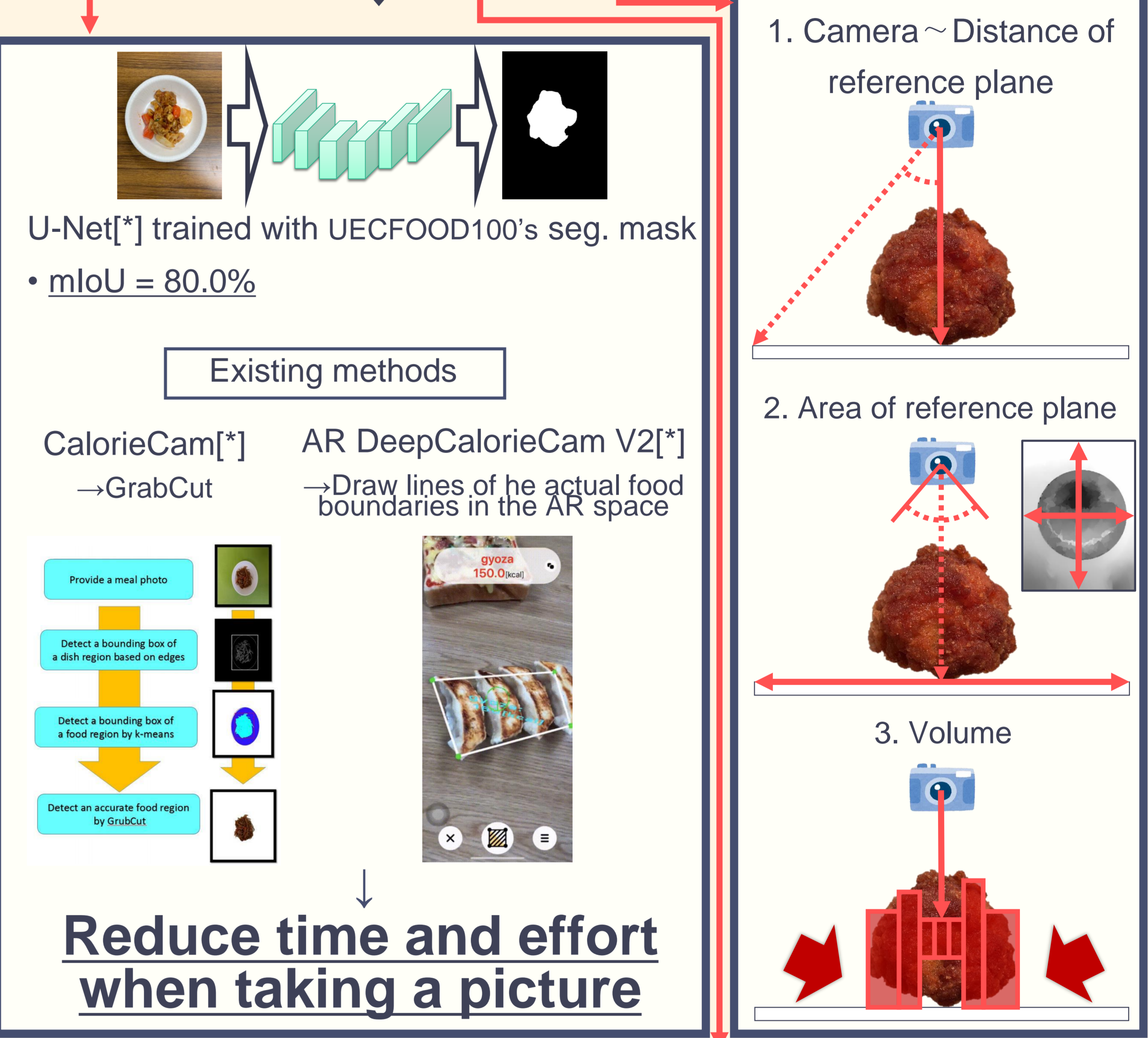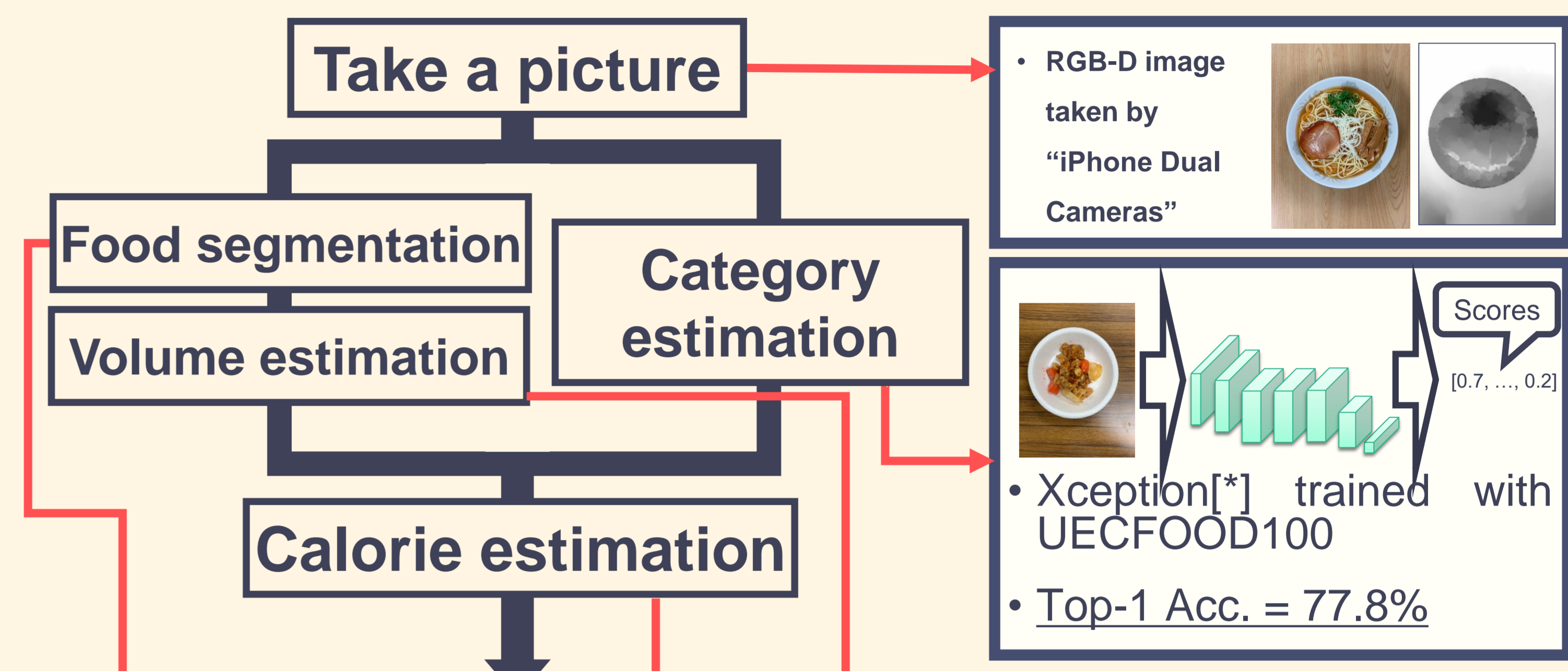
※Food calorie estimation is implemented only following devices
- iPhone 7/8 Plus
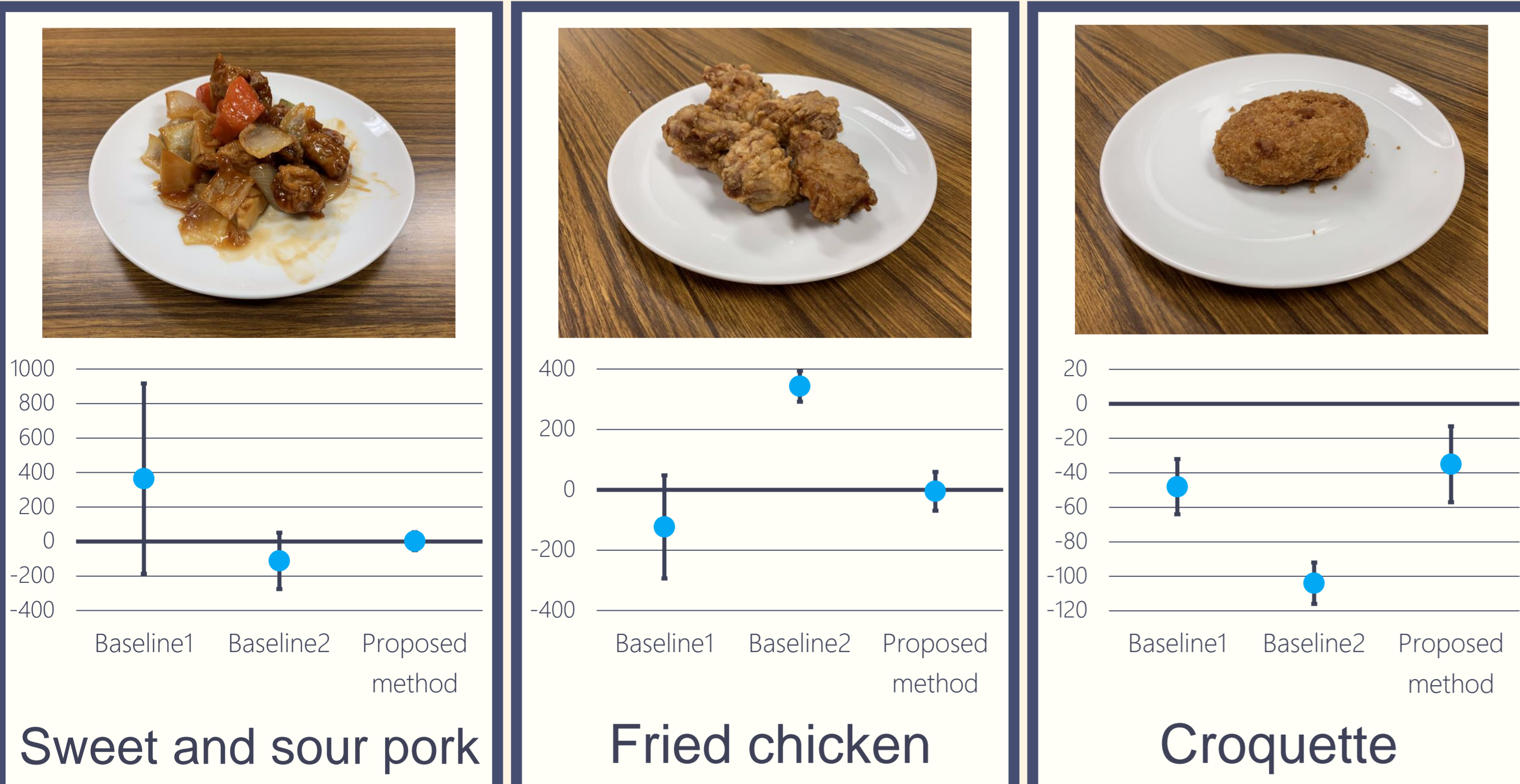- iPhone X/XS/XS Max
- iPhone 11 Pro/Pro MAX

## Experiments · Evaluation

**Comparative evaluation of food calorie estimation**

CalorieCam(Baseline1) / AR DeepCalorieCam V2(Baseline2) / **Proposal method**

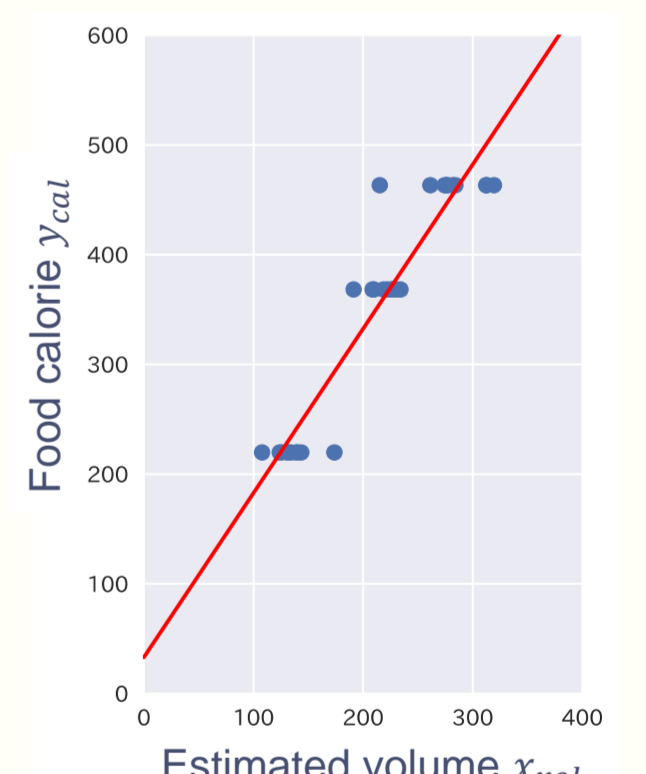※The mean and standard deviation of the errors in the calorie estimations

Sweet and sour pork

Fried chicken

Croquette

### Easier and more accurate estimation than Existing methods

### → Effect of regression from volume

## Proposed method

Take a picture

Food segmentation

Volume estimation

Category estimation

Calorie estimation

- RGB-D image taken by "iPhone Dual Cameras"

- Xception[*] trained with UECFOOD100
- Top-1 Acc. = 77.8%

Scores [0.7, ..., 0.2]

U-Net[*] trained with UECFOOD100's seg. mask
- mIoU = 80.0%

1. Camera ～ Distance of reference plane

2. Area of reference plane

3. Volume

**Existing methods**

CalorieCam[*]
→GrabCut

- Provide a meal photo
- Detect a bounding box of a dish region based on edges
- Detect a bounding box of a food region by k-means
- Detect an accurate food region by GrubCut

AR DeepCalorieCam V2[*]
→Draw lines of he actual food boundaries in the AR space

gyoza 150.0kcal

### Reduce time and effort when taking a picture

Food calorie $y_{cal}$ regression from the volume $x_{vol}$

↓

### Highly accurate regression

## Conclusion · Future work

- We estimated food volumes and food calories based on the RGB-D image taken by "iPhone Dual Cameras".
  - In the calorie estimation, our system achieved higher accuracy than existing methods
- Increase the number of food categories the system can handle with. Currently supports 3 food categories.
  - Take RGB-D images of real foods the calorie amount of which are known by using iPhones having two backside cameras.

[1] Y. Matsuda, H. Hoashi, and K. Yanai. Recognition of multiple-food images by detecting candidate regions. In Proc. of IEEE International Conference on Multimedia and Expo (ICME), 2012.
[2] O Ronneberger, P Fischer, and T Brox. U-Net: Convolutional Networks for Biomedical Image Segmentation. In Proc. of Medical Image Computing and Computer-Assisted Intervention (MICCAI), pp. 234–241, 2015.
[3] K. Okamoto and K. Yanai. An Automatic Calorie Estimation System of Food Images on a Smartphone. In Proc. Of ACM MM Workshop on Multimedia Assisted Dietary Management (MADiMa), 2016.
[4] R. Tanno, T. Ege, and K. Yanai. AR DeepCalorieCam V2: Food Calorie Estimation with CNN and AR-based Actual Size Estimation. In Proc. of ACM Symposium on Virtual Reality Software and Technology (VRST), 2018.
[5] F. Chollet. Xception: Deep Learning with Depthwise Separable Convolutions. In Proc. of IEEE International Conference on Computer Vision and Pattern Recognition (CVPR), pp. 1800–1807, 2017.